Influence of Auditory Distraction upon Intelligibility Ratings in Dysarthria

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BACKGROUND

- Intelligibility of non-disordered speech is known to be adversely affected by background noise [1-3].
- Research has not yet considered how auditory distraction, in the form of background noise, affects the intelligibility of dysarthric speech.
- Listeners attempt to comprehend dysarthric speech in a multitude of environs. Therefore, research examining the effects of noise upon speech intelligibility in dysarthria may inform the development of facilitative strategies aimed at enhancing listener comprehension.

RESEARCH QUESTIONS

- Is the intelligibility of dysarthric speech affected similarly to normal speech under conditions of auditory distraction?
- Are differential effects of auditory distraction observed in speakers with different primary characteristics of dysarthria?

HYPOTHESES

- Listener ratings of dysarthric speech will show greater declines in intelligibility with increased levels of auditory distraction than normal speech.
- As severity of dysarthria increases, the negative effects of auditory distraction upon speech intelligibility will increase.

METHOD

- **Listeners:** Fifty-six (56) undergraduate female listeners ranging in age from 18 to 45 years (*M = 22 years)*.
- **Procedure:** Listeners were asked to make perceptual judgements of intelligibility across four conditions of auditory distraction: no auditory distraction and distraction at +3dB SNR, 0 dB SNR, and -3dB SNR. Listeners completed the task in four groups of 14. Order of conditions was counterbalanced across groups.
- **Auditory distraction:** Multi-talker babble was employed for auditory distraction. For distraction conditions, babble began with the speech stimuli and continued during the rating process.
- **Speech stimuli:** Were derived from the first five sentences of the Grandfather passage. Recordings were obtained from three adult males with traumatic brain injury (TBI) and three age-matched controls (see Table 1). A total of eight samples were played at each condition – six speech samples and two repetitions for reliability purposes.

METHOD cont.

- **Intelligibility:** Rated by 10 students of speech pathology using direct magnitude estimation (free modulus paradigm). Intelligibility described as "the ease with which speech could be understood" [4].
- **Statistics:** A 2 x 4 mixed between-within subjects ANOVA ($p<0.05$) was conducted to explore the effects of speaker group and distraction. Post hoc pairwise comparisons were conducted using Holm-Sidak pairwise multiple comparisons with *p* values adjusted for multiple comparisons. Secondly, examination of individual TBI participant data was conducted using a series of three one-way repeated measures ANOVA with an alpha level of 0.05. Post hoc analysis was conducted using pairwise multiple comparison procedures (Tukey test) with adjusted alpha.

Table 1: Characteristics of the dysarthric speakers.

Speaker	Age	Time post-injury	Dysarthria diagnosis
S1	58	39	Severe spastic-ataxic
S2	52	32	Moderate ataxic
S3	35	16	Moderate-severe spastic- flaccid-ataxic

- **Reliability:** Mean intra-participant reliability was 0.85 (SD = 0.14). Inter-listener reliability was 0.98 (Cronbach's alpha).

RESULTS

- Significant effects were observed for group ($F=49.57$, $p=0.01$) and condition ($F=75.48$, $p<0.05$) with the group X condition interaction also significant ($F=30.74$, $p<0.05$) (see Figure 1).
- Post-hoc testing indicated that perceived intelligibility of the dysarthric group was significantly reduced at each condition ($p<0.05$).

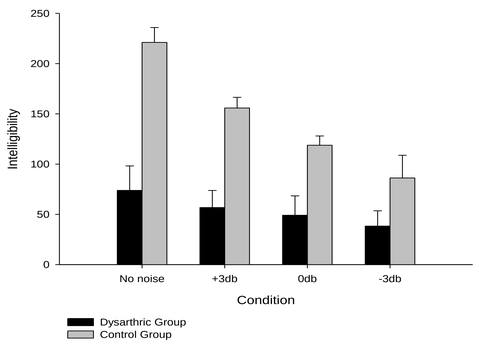
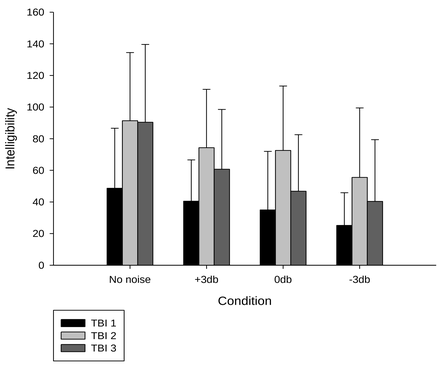


Figure 1: Intelligibility ratings across group and condition .

RESULTS cont.

- All post hoc pairwise tests were significant ($p<0.001$) for the control group indicating that intelligibility ratings decreased significantly with each condition of reducing SNR.
- The dysarthric group exhibited significantly reduced perceived intelligibility at both the 0 dB ($p<0.05$) and -3 dB ($p<0.05$) SNR conditions compared to the no noise condition only.

Figure 2: Intelligibility ratings for individual dysarthric speakers across conditions.



- All speakers exhibited significant changes to perceived speech intelligibility across conditions ($p<0.001$) (see Figure 2) with differential effects observed on post-hoc testing (see author for full results).

DISCUSSION

- The perceived intelligibility of dysarthric speech was not affected by background noise in the same way as normal speech.
- This may have been due to: (1) Listener effort, (2) Cognitively motivated selective attention; (3) Measurement effect.
- Differential effects were noted by speaker with the intelligibility ratings for speaker 3 more affected by decreasing SNRs than either speaker 1 or 2.
- These results suggest that the distinctive speech characteristics of dysarthria type may be uniquely influenced by the presence of noise.
- Future research should consider: (1) Modification of the dependent variable; (2) Use of word or phrase-level experimental stimuli; and (3) acoustic analysis of perceptual speech features.

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